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SYSTEMATICS OF ASIOPSOCIDAE (PSOCOPTERA) INCLUDING *PRONOTIOPSOCUS AMAZONICUS* N. GEN. N. SP.

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ABSTRACT

Pronotiopsocus n. gen. is described with *P. amazonicus* n. sp. as the type species. The new genus is placed in family Asiopsocidae together with *Asiopsocus* Günther and *Notiopsocus* Banks. The 3 genera are diagnosed. Their probable plesiomorphous characters are derived by outgroup comparison with superfamily Caecilioidea. These characters are taken to represent a hypothetical common ancestor of the Asiopsocid genera, which is used to reconstruct the phylogeny of these genera. *Pronotiopsocus* represents one line of the phylogeny with *Notiopsocus* and *Asiopsocus* representing a sister lineage. Geographical distributions suggest great antiquity with a Pangaean origin of the family. The furcation of the lineage bearing *Notiopsocus* and *Asiopsocus* may have coincided with the initial breakup of Pangaea. Absence of *Notiopsocus* from India, Madagascar, and Australia may be due to insufficient sampling of these regions or to the timing of origin and spread of the genus relative to the breakup of Gondwanaland.

RESUMEN

Pronotiopsocus gen. n. se describe con el tipo *P. amazonicus* sp. n. El nuevo género se coloca en la familia Asiopsocidae, junto con *Asiopsocus* Günther y *Notiopsocus* Banks. Los 3 géneros se diagnosan. Sus caracteres plesiomorfos probables se deriven por comparación con la superfamilia Caecilioidea. Éstos caracteres se toman como representantes de un antepasado común hipotético de los géneros asiopsócidos, empleado para la reconstrucción de la filogenia de éstos géneros. *Pronotiopsocus* representa una linea de la filogenia con *Notiopsocus* y *Asiopsocus* representando una linea-

hermana. Las distribuciones geográficas sugeren gran antiguidad con un origen Pangean de la familia. La furcación de una linea llevando *Notiopsocus* y *Asiopsocus* puede haber coincidido con la fragmentación inicial de Pangaea. La ausencia de *Notiopsocus* de India, Madagascar, y Australia puede ser debido a la falta de investigación en éstas regiones, o puede ser debido al patrón temporal del origen y distribución de aquel género en relación a la fragmentación de Gonduanalandia.

The family Asiopsocidae Mockford and García Aldrete (1976) was based on the genera *Asiopsocus* Günther and *Notiopsocus* Banks. It was regarded by its authors as a phylogenetic sister group with the lineage represented by families Caeciliidae, Amphipsocidae, Stenopsocidae, and Polypsocidae (or combinations of these) and was, therefore, regarded as a superfamily while the latter lineage was also given status as a single superfamily, Caecilioidea. The 2 superfamilies constitute Group Caecilietae Pearman.

Recently, I have received material from Amazonian Brazil representing a 3rd genus of Asiopsocidae. The new genus is notable in having among its characters some identical with *Asiopsocus*, some identical with *Notiopsocus*, some intermediate between these genera and some intermediate between the set of *Asiopsocus* plus *Notiopsocus* and the Superfamily Caecilioidea.

In this paper the new genus and its single included species are described, the family Asiopsocidae and its genera are defined morphologically, and the biogeographic and phylogenetic relationships of the genera are discussed.

Materials and Methods

The description of *Pronotiopsocus amazonicus* n. gen., n. sp. is based on 2 female specimens. These are compared with series of 4 species of *Notiopsocus* and one of *Asiopsocus* at hand. All figures were made with aid of a drawing tube. Measurements were made with a filar micrometer. The micrometer unit was 0.462 μm. The outer angle of the mandible has not been used previously to my knowledge. It is taken as follows: assuming that the mandible on a slide has assumed the flattest possible position, one draws a camera-lucida outline of the mandible. The 2 mandibles are not mirror images, and I have consistently used the right mandible in this study, which shows a more prominent molar lobe (Fig. 2m) and a poorly developed premolar lobe, if any (Fig. 1p). One draws a line from the most basal point on the median margin of the molar lobe (Fig. 2b), generally marked by a tiny beard of spines, to the most basal point on the lateral margin of the mandible (Fig. 2l); one constructs a perpendicular to this line on the outline tangent to the tip of the apical incisor tooth. One draws a line parallel to line bl, crossing the perpendicular, and tangent to the most distal point on the mandible. From the point where this line crosses the perpendicular, one draws a line to l. The angle formed by the latter line with bl is the outer angle (Fig. 2a). A large outer angle, as seen in Caecilioids (range 68°-71° for 5 species representing 5 genera) appears to be correlated with a relatively longer mandible as compared with the width of its base, while a smaller outer angle, as seen in Asiopsocids, is generally correlated with a relatively shorter mandible.

Pronotiopsocus Mockford NEW GENUS
Fig. 1-11

DIAGNOSIS. Male unknown. Female micropterous, wings represented by a slight bulge on each side of meso- and metatergum. Showing usual characters of micropterous psocids: ocelli absent, thoracic notal lobes not expressed, tarsal ctenidia absent, sense cushions of paraprocts greatly reduced. Antennae broken off and missing beyond scape and pedicel in specimens on hand. Dorsal ecdysial line of head (Fig. 3) very distinct, with arms reaching nearly to antennal sulci but becoming faint at distal ends. Compound eyes relatively small but with numerous ommatidia. Labrum (Fig. 4) with pigment pattern suggesting broad pair of longitudinal bars. Distal margin of labrum broad, relatively flat, limited by 2 stylets of moderate length. Distal inner labral sensilla (Fig. 5) a row consisting from middle outward in either direction of a, b, c, d (alternating pit-seta-pit-seta); no row of small setae on outer surface opposite inner sensilla. Mandibles (Fig. 1, 2) with incisor region relatively elongate; outer angle of mandible = 62°. Lacinia (Fig. 6, 6a) with tip broad, with a few broad, rounded denticles of low relief; a decided bulge on lateral surface before tip. Pretarsal claw (Fig. 7) with broad, short pulvillus truncated or slightly expanded apically and with long basal seta. Pearman's organ represented only by 'mirror'. Subgenital plate (Fig. 8) broadly rounded distally; pigmented area with broad, rounded median anterior indentation, narrowing and extending to posterior margin in middle; setae evenly distributed over surface of pigmented area. Ovipositor valvulae (Fig. 9): 1st valvula slightly curved, rounded apically; largely membranous but sclerotized and pigmented basally; 2nd valvula straight, relatively narrow, rounded apically; 3rd valvula apparently represented by a large seta and possibly also by a small lobe on posterior margin of clunium before the seta. Spermatheca (Fig. 10) with broad, rounded,

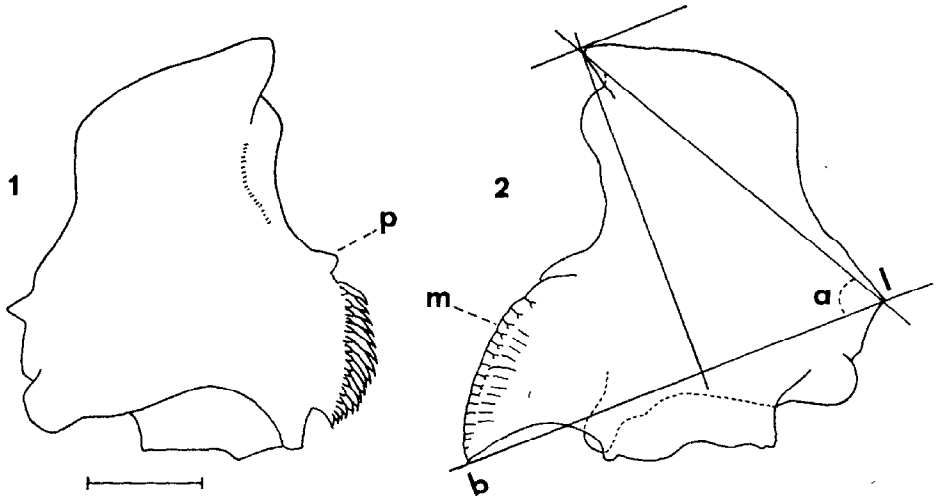

Fig. 1-2. *Pronotiopsocus amazonicus* n.sp. ♀. 1.) Left mandible, p = premolar lobe; scale = 0.05 mm. 2.) Right mandible, m = molar lobe; straight lines and letters b and l indicate construction for determining a, the outer angle of the mandible (see text); scale as in Fig. 1.

slightly sclerotized region around spermapore; duct relatively short, entirely surrounded by narrow sheath; neck of sack at junction with duct relatively broad, thickened. Epiproct (Fig. 11) semicircular, bearing several short, stout setae. Paraproct (Fig. 11) with sense cushion represented by 2 trichobothria with basal florets and a short, stout seta, or only stout seta; median margin bearing a prominent duplex spine flanked dorsally and ventrally by a stout seta; numerous other setae confined mostly to medioventral quadrant of paraproct.

TYPE SPECIES. *Pronotiopsocus amazonicus* n. sp.

Pronotiopsocus amazonicus Mockford NEW SPECIES
Fig. 1-11

Structural features as described for the genus.

MEASUREMENTS (μm). Hind femoral length = 378, hind tibial length = 578, length of 1st hind tarsomere = 180, length of 2nd hind tarsomere = 100. IO/d (least distance between compound eyes in dorsal view divided by transverse diameter of compound eye in dorsal view) = 5.29.

COLOR (in alcohol). Compound eyes black. Remainder of head pale tawny brown, darker on sulci, ecdysial lines, and mandibles, creamy white on areas of vertex shown unstippled on Fig. 3. Thorax and membranous portion of abdomen grayish white except sulci, intersegmental lines of thorax, and slender, transverse dorsal sclerite of base of abdomen tawny brown. Legs pale tawny brown. Clunium, epiproct, paraprocts, and pigmented area of subgenital plate pale tawny brown.

HOLOTYPE. Micropterous ♀, BRAZIL: Amazonas, Rio Tarumã Mirím at confluence with Rio Negro, approximately 20 km northwest along Rio Negro from Manaus, 30-IX-1976, J. Adis collector. Paratype, micropterous ♀, type locality, 1-III-1976, J. Adis collector, in tree ecletor traps. The holotype will be deposited in the Instituto Nacional de Pesquisas da Amazonia, Manaus, Brazil. The paratype will be deposited for the present in my collection and ultimately in the Florida Collection of Arthropods, Gainesville, Florida.

DEFINITION OF FAMILY ASIOPSOCIDAE

With the addition of *Pronotiopsocus*, the Family Asiopsocidae may be defined by the following characters:

1. lacinial tip broad with denticles of low relief;
2. short labral stylets present;
3. mandible of only moderate length compared to its basal width; outer mandibular angle 56-62°;
4. pulvillus variable: broad, narrow, or absent;
5. winged form with long R-M fusion in hindwing;
6. Pearman's organ represented only by 'mirror' (*Pronotiopsocus*) or field of minute spines (*Asiopsocus*), *or* absent (*Notiopsocus*);
7. first and second ovipositor valvulae, when present and distinct, with distal ends rounded;
8. ventral abdominal vesicles absent (present in most Caecilioidea);
9. apophyses of subgenital plate absent (present in many Caeciliodea).

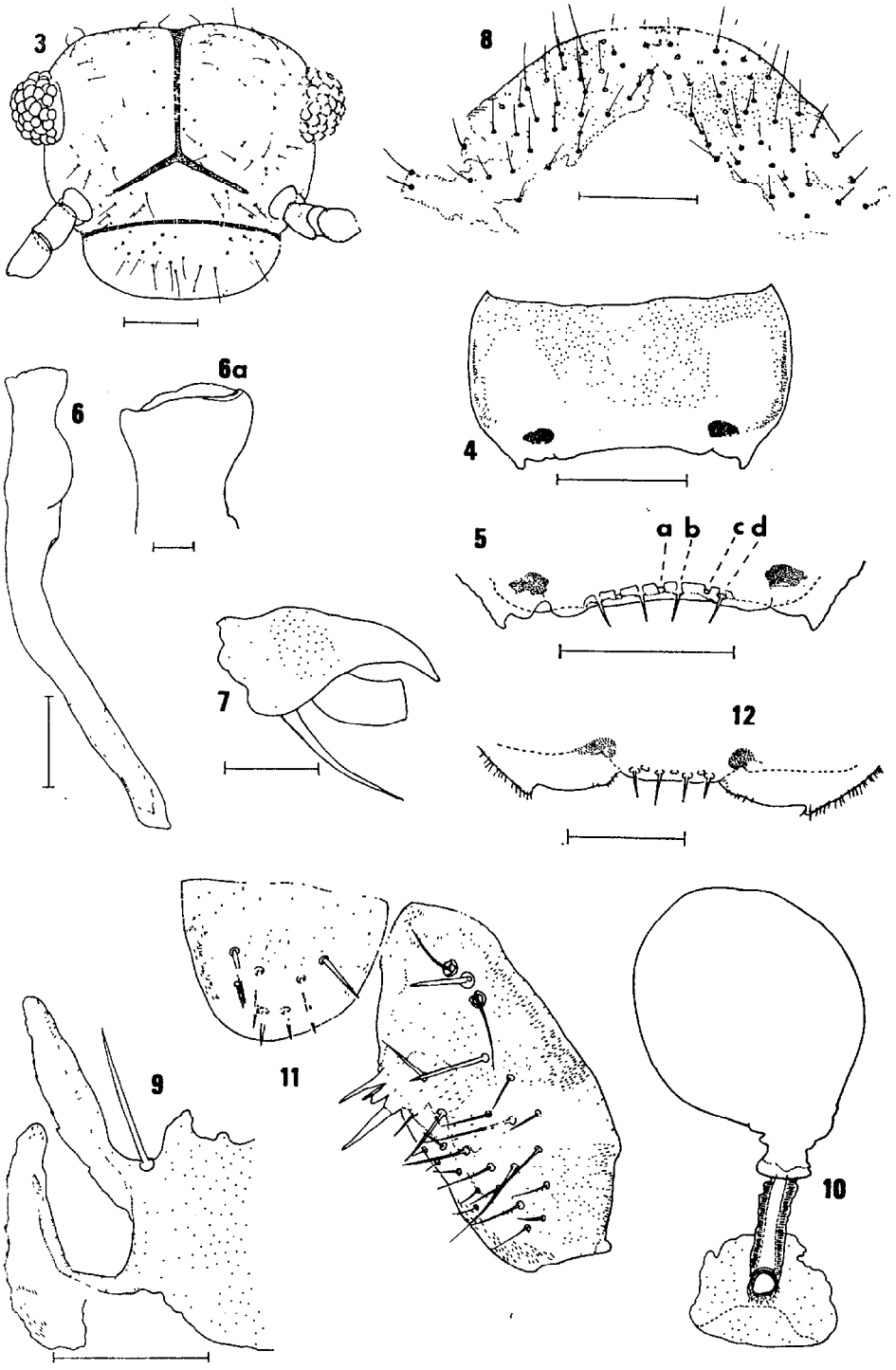

Fig. 3-11. *Pronotiopsocus amazonicus* n.sp. ♀. 3.) Head in dorsal view; scale = 0.1 mm. 4.) Labrum showing pigmentation pattern; scale = 0.1 mm. 5.) Distal margin of labrum showing inner sensilla (a, b, c, d); scale = 0.1 mm. 6.) Lacinia, scale = 0.5 mm. Fig. 6-a. Lacinial tip; scale = 0.01 mm. 7.) Pretarsal claw; scale = 0.01 mm. 8.) Subgenital plate; scale = 0.1 mm. 9.) Ovipositor valvulae; scale = 0.05 mm. 10.) Spermatheca; scale of Fig. 9. 11.)

Structural Comparisons and Phylogeny of the Asiopsocid Genera

The family Asiopsocidae consists at present of the 3 genera *Asiopsocus*, *Notiopsocus*, and *Pronotiopsocus*. The genera are differentially diagnosed by the characters in Table 1.

For derivation of a phylogeny of the Asiopsocidae, characters of an ancestral asiopsocid were synthesized by comparison between each of the Asiopsocid genera and the Caecilioidea. Structural features of Caecilioidea were reviewed by Mockford and García Aldrete (1976) and Mockford (1978). Similarities are taken to indicate plesiomorphous character states for the Asiopsocidae. Presumed plesiomorphous states which are apomorphous in at least one of the Asiopsocid genera are valuable in determining phylogeny and are discussed below.

Pronotiopsocus resembles the Caecilioidea in possession of a broad pulvillus, lack of microtrichs of the base of the pretarsal claw, and possession of the mirror of the coxal organ. *Notiopsocus* resembles the Caecilioidea in possession of the mesepisternal sulcus, possession of a sizable sclerotized 3rd valvula, and in ciliation of the female forewing. *Asiopsocus* resembles certain Caecilioids, probably near the base of that group, in its very broad, markedly denticulate lacinial tip. Both *Notiopsocus* and *Pronotiopsocus* resemble Caecilioidea in possession of a sclerotized, free 2nd ovipositor valvula. The 2nd valvula of *Asiopsocus* is a membranous bulge on the 3rd or is lacking entirely. Macroptery, found in most Caecilioidea, and in females of *Notiopsocus* and males of *Asiopsocus*, is presumed to be the ancestral condition of Asiopsocidae.

Assuming that the 9 states of the above paragraph characterized the ancestral Asiopsocid, how were the modern genera derived from it? Each possible pair of these genera shares at least one apomorphous state of the hypothesized ancestral characters. Therefore, it seems reasonable to try to adduce a phylogeny in which 2 of the genera are derived as one lineage and the 3rd as another lineage. Obviously, some parallel changes would occur in such a phylogenetic pattern. I have chosen the phylogeny containing the fewest parallel changes, apparently representing the simplest hypothesis. *Pronotiopsocus* is derived as one lineage and *Notiopsocus* and *Asiopsocus* are derived as a sister line. This pattern contains 3 parallel changes, while the other possible patterns contain at least 4. The *Pronotiopsocus* lineage is characterized by the apomorphous states of the lacinial tip being somewhat narrowed, the mesepisternal sulcus being absent, the 3rd valvula being greatly reduced, and the female being micropterous. The hypothesized common ancestor of *Notiopsocus* and *Asiopsocus* is characterized by the apomorphous states of the pulvillus being slender, and the base of the pretarsal claw bearing microtrichs. The *Notiopsocus* line derived from this ancestor is characterized by the apomorphous states of the lacinial tip being narrowed, the pulvillus being absent, and the male being micropterous. The *Asiopsocus* line is characterized by the apomorphous states of the mesepisternal sulcus being absent, the 2nd valvula being reduced and membranous, the 3rd valvula being membranous, the female being micropterous, and wing setae (in the male) being absent.

TABLE 1. DIAGNOSTIC CHARACTER STATES OF THE GENERA OF ASIOPSOCIDAE.

	Asiopsocus	*Notiopsocus*	*Pronotiopsocus*
Adult form	♂ normal, ♀ micropterous	♂ micropterous, ♀ normal	♂ unknown, ♀ micropterous
Inner clypeal shelf	narrow	narrow	broad
Nature of frons	narrow rim on posterior clypeal margin	apparently broad; ecdysial arms obscure	broad triangular area
Pigmentation pattern of labrum	2 longitudinal bars	none visible	two obscure broad bands
Distal inner labral sensilla	a, b, c present	a, b, c, d present	a, b, c, d present
Distal outer labral sensilla	row of 4-5 setae	row of 4 setae	none
Outer mandibular angle	58-61°	56-60°	62°
Region of lacinia before tip	broadly bulging	broad but not bulging	slightly bulging
Pulvillus	present but slender or absent	absent	present, broad
Base of pretarsal claw	with microtrichs or not	with microtrichs	without microtrichs
Mesepisternal sulcus[1]	absent	present	absent
Pearman's organ	absent	absent	mirror only
3rd ovipositor valvula	large, mostly membranous, no seta	large, sclerotized, with seta	minute, sclerotized, with seta
Sheath of spermatheca	short	short	medium length

[1]Absence of this structure in *Notiopsocus* reported by Mockford and García Aldrete (1976) was in error.

Geographic Distribution of Asiopsocidae

The family Asiopsocidae is known from North America, Eurasia, tropical South America, and tropical Africa. It is not known from Madagascar, India, and Australia. *Asiopsocus* presents a truly bizarre distribution, with one species in Mongolia (Günther 1968, 1974), one in Arizona and adjacent Sonora (Mockford and García Aldrete 1976, Mockford 1977), and one in Spain (Lienhard 1981). *Notiopsocus* is entirely neotropical and tropical African except for one species in southern Florida (personal observation), and *Pronotiopsocus* is known only from Amazonian Brazil.

The distribution of *Asiopsocus* suggests great antiquity. Its relationship to *Notiopsocus*, adduced above, suggests origin as the northern vicariant in the phylogenetic event which led to fragmentation of the common ancestor of those 2 genera. If this event coincided with the breakup of Pangaea, one can presumably place it in time as Late Triassic to Early Jurassic, 203-192 m.y.BP (Seyfert and Sirkin 1979). The common ancestor of these 2 genera must have separated from *Pronotiopsocus* before that time.

The absence of Asiopsocidae in Madagascar, India, and Australia, though possibly due to inadequate sampling, may be due to the timing of separation of plates. If *Notiopsocus* was spreading eastward from a, let us suppose, South American region of Origin and reached Africa before that continent's separation from South America (Late Jurassic to Early Cretaceous, 150-130 m.y.BP according to Seyfert and Sirkin 1979), it may not have been able to reach the plate containing Antarctica, Australia, and India, which separated from that containing Africa and Madagascar between Late Triassic and Early Jurassic, 205-160 m.y.BP (Seyfert and Sirkin 1979). It also may not have been able to reach Madagascar, which separated from Africa between Middle Jurassic and Late Cretaceous, 172-90 m.y.BP (Seyfert and Sirkin 1979).

Presence of *Notiopsocus* in Mexico and southern Florida is probably explainable as part of a post-Pleistocene invasion of tropical South American insect species into southern North America (Halffter 1964).

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FEMALE CALLING BEHAVIOR IN *EPHESTIA ELUTELLA* AND *E. FIGULILELLA* (LEPIDOPTERA: PYRALIDAE)

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ABSTRACT

The sexual calling behavior of *Ephestia elutella* (Hübner) and *E. figulilella* Gregson females was observed in the laboratory under a 14L:10D photoperiodic regime. *E. elutella* females showed a broad mid-scotophase peak of calling activity with low levels of calling continuing throughout the photophase. *E. figulilella* females showed a narrower mid-scotophase calling peak with little or no photophase activity.

RESUMEN

El comportamiento de las hembras en 'llamar", eso es, atraer a los machos, fue observado en 2 especies, *Esphestia elutella* (Hubner) y *E. figulilella* Gregson en un laboratorio debajo un regimen de fotoperíodo de 14L: 10 D. Hembras de *E. elutella* mostraron un pico ancho de actividad de llamar en el medio del período de oscuridad, con niveles bajos de esta actividad siguiendo por todo el perîodo de luz. Las hembras de *E. figulilella* mostraron un pico más angosto en el medio del período de oscuridad, con poca o ninguna actividad en el período de luz.

Ephestia elutella (Hübner) and *E. figulilella* Gregson frequently co-occur, and are often found in sympatry with 3 other stored-product infesting phycitid moths: *Plodia interpunctella* (Hübner), *E. kuenhiella* Zeller, and *E. cautella* (Walker) (Reed and Livingstone 1937, Donahoe et al. 1949, Hoppe and Levinson 1979). Inasmuch as the primary component of the female sex pheromone (*Z,E*)-9,12-tetradecadien-1-ol acetate (ZETA) is the same in all 5 species (Brady and Daley 1972), and the males of any 1 species can be attracted to and attempt to mate with a female of any of the other species (Ganyard and Brady 1972, Krasnoff, unpublished data) it was hypothesized that differences in diel periodicity of sexual activity might help to maintain reproductive isolation in this group.

Daily rhythms underlying various aspects of sexual behavior and physiology have been studied in 3 stored-product infesting phycitid moths, *P. interpunctella* (Nordlund and Brady 1974, Coffelt et al. 1978), *E. kuenhiella* (Calvert and Corbet 1973), and *E. cautella* (Coffelt et al. 1978).

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